Resource Planning for Accelerator Operations and Development

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Overview of Accelerator Operations

- Mission of Accelerator Program
- Elements of the Program
- Organization (AD)
- Management Elements (AD)
- Budget Projections
- Staffing needs and projections
- Managing Risks
- The End

The AD Mission

This Review

- provides the expertise to reliably and cost-effectively deliver particle beams to qualified researchers conducing basic research at the frontiers of high-energy physics and related disciplines;
- operates, maintains, and improves the existing Fermilab accelerator complex and beam lines;

Not covered in this review

- conducts particle beam physics research; and
- develops, designs, and builds the accelerators and subsystems required to advance the field.

Other Divisions and Sections provide major support for carrying out this mission

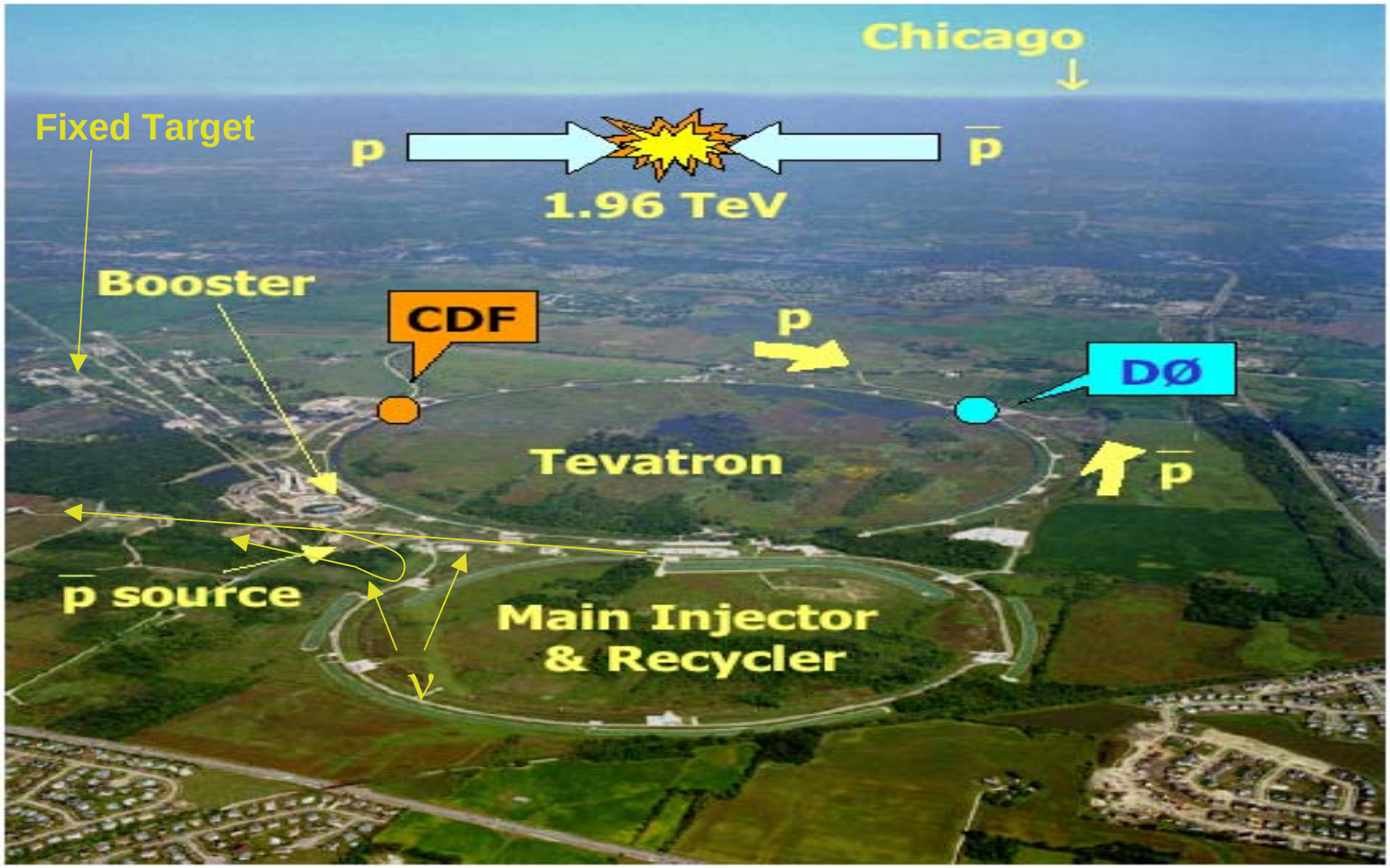
Current Accelerator Programs

- Collider Program
- Run II Luminosity and Reliability Upgrades
- Neutrino Program – MiniBooNE and NUMI
- Proton Improvement Plan
- Slow-spill extracted beams
- Accelerator R&D (Not being reviewed)
  - **Fermilab NICADD PhotoInjector Laboratory**
  - **Neutrino Facilities (Muon Storage Ring), Linear Collider, Proton Driver**
- operating, maintaining, improving facilities

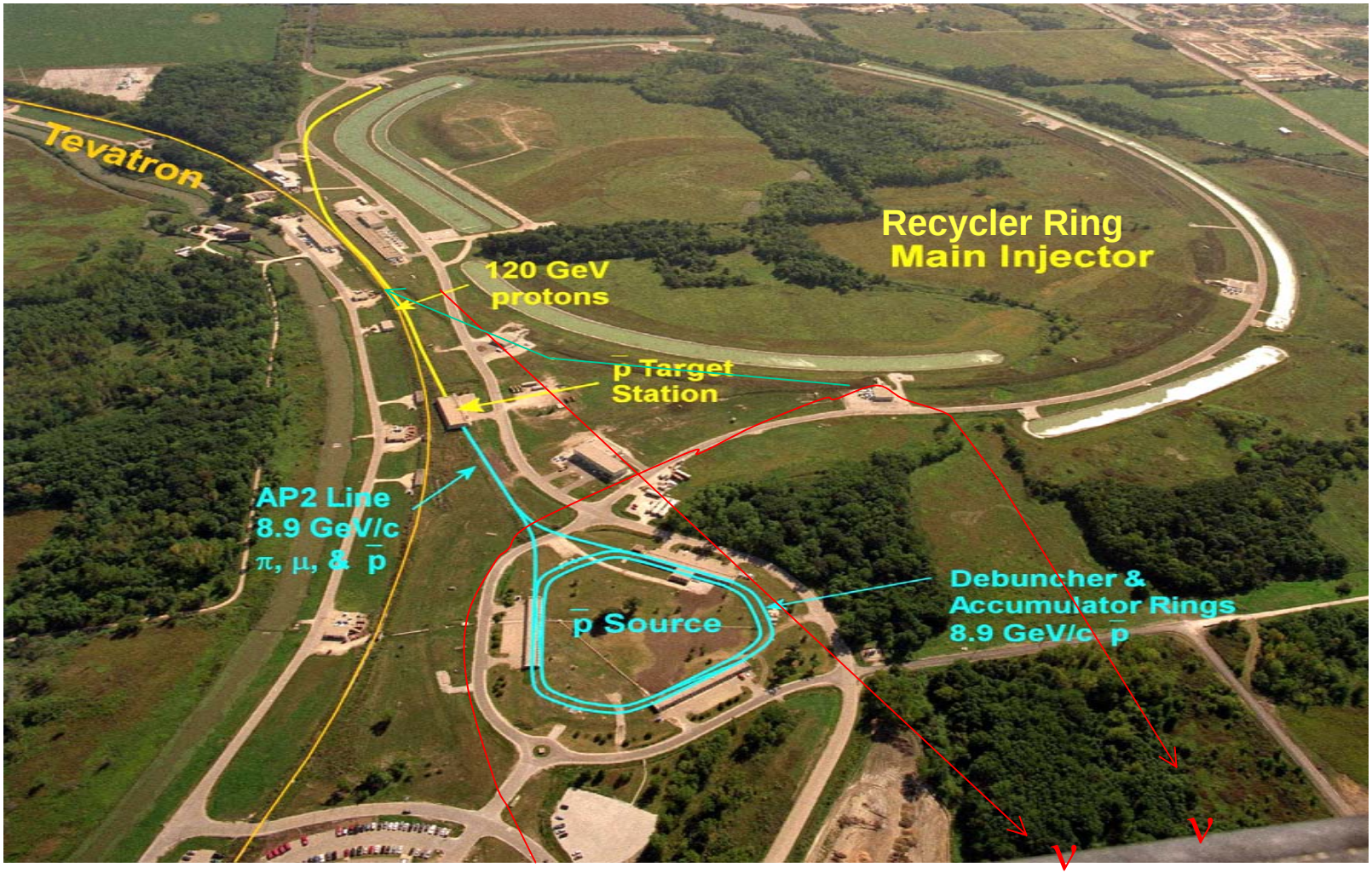
Contributions from Other Divisions

- The Accelerator Division has overall responsibility for the Accelerator Program
- The Technical Division mission supports the Accelerator Program
  - Design, fabricate, and repair accelerator components
- Particle Physics Division and Computing Division provide crucial skills for such things as instrumentation and controls in addition to supplying help to meet the extra manpower requirements during shutdowns

Overview of Accelerator Complex



Overview of Main Injector, Antiproton Source, and neutrino beams



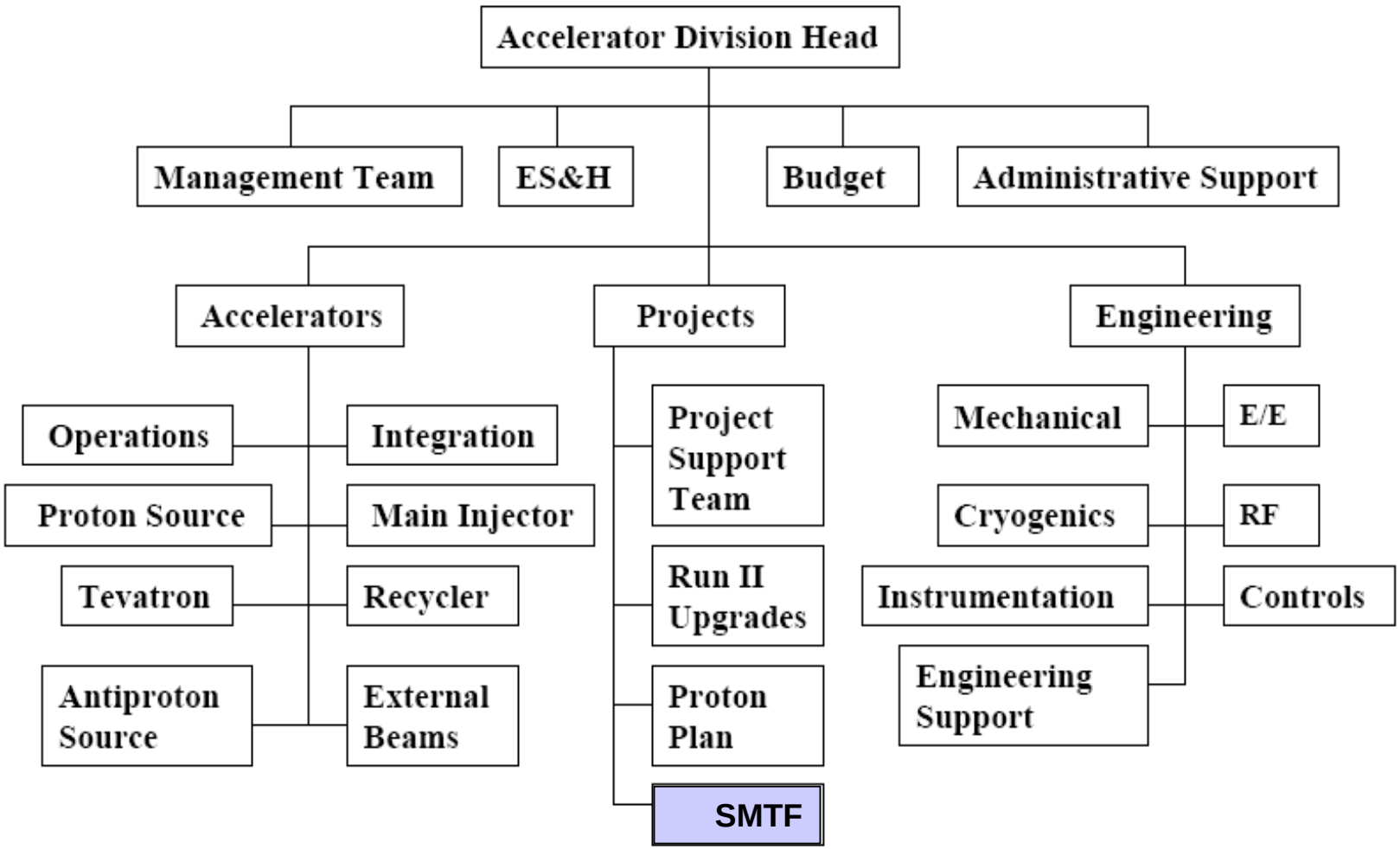
Accelerator Complex Statistics

- ~**584** people and **$ 82 M** in **FY05**
- Accelerators – 6 rings, 1 linac, 3 electrostatic generators
  - **Proton Source: 2- Cockcroft-Waltons, LINAC, Booster**
  - **Main Injector**
  - **AntiProton Source: Debuncher & Accumulator**
  - **Additional antiproton storage and cooling: Recycler Ring (permanent magnets), Pelletron (for electron cooling)**
  - **Tevatron**
- External Beam Lines from Booster and MI
  - **MiniBooNE, NuMI, SW120 (E-907 MIPP, Test Beams)**

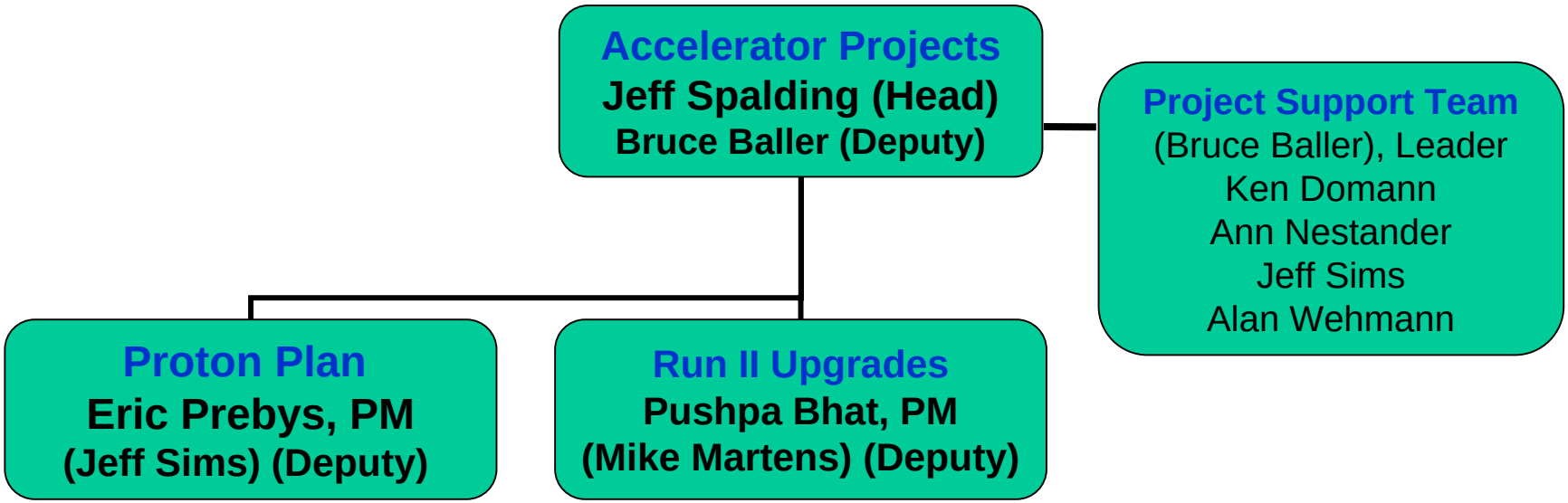
Elements of AD Management

- ES&H + Self-Assessment are most important elements
- Program and Budget – annual budget review
- Identifying and Resolving Problems
- Optimizations – often lead to re-organization
- Technical Reviews
- Interactions with our Stakeholders
- Performance Metrics (a few examples)
  - **Project Milestones – *e.g.* NUMI, Run II Upgrade**
  - **almost *every* weekday at AD/Integration meeting**
    - **Review accelerator performance vs. expectation & recent history**
    - **Shot Data Analysis - Run II Luminosity Upgrade Plan – correlations**
    - **Proven to be a vital component of our current successes**
  - **Monthly AD statistics, accident analysis, ES&H training status**

Schematic of AD Organization



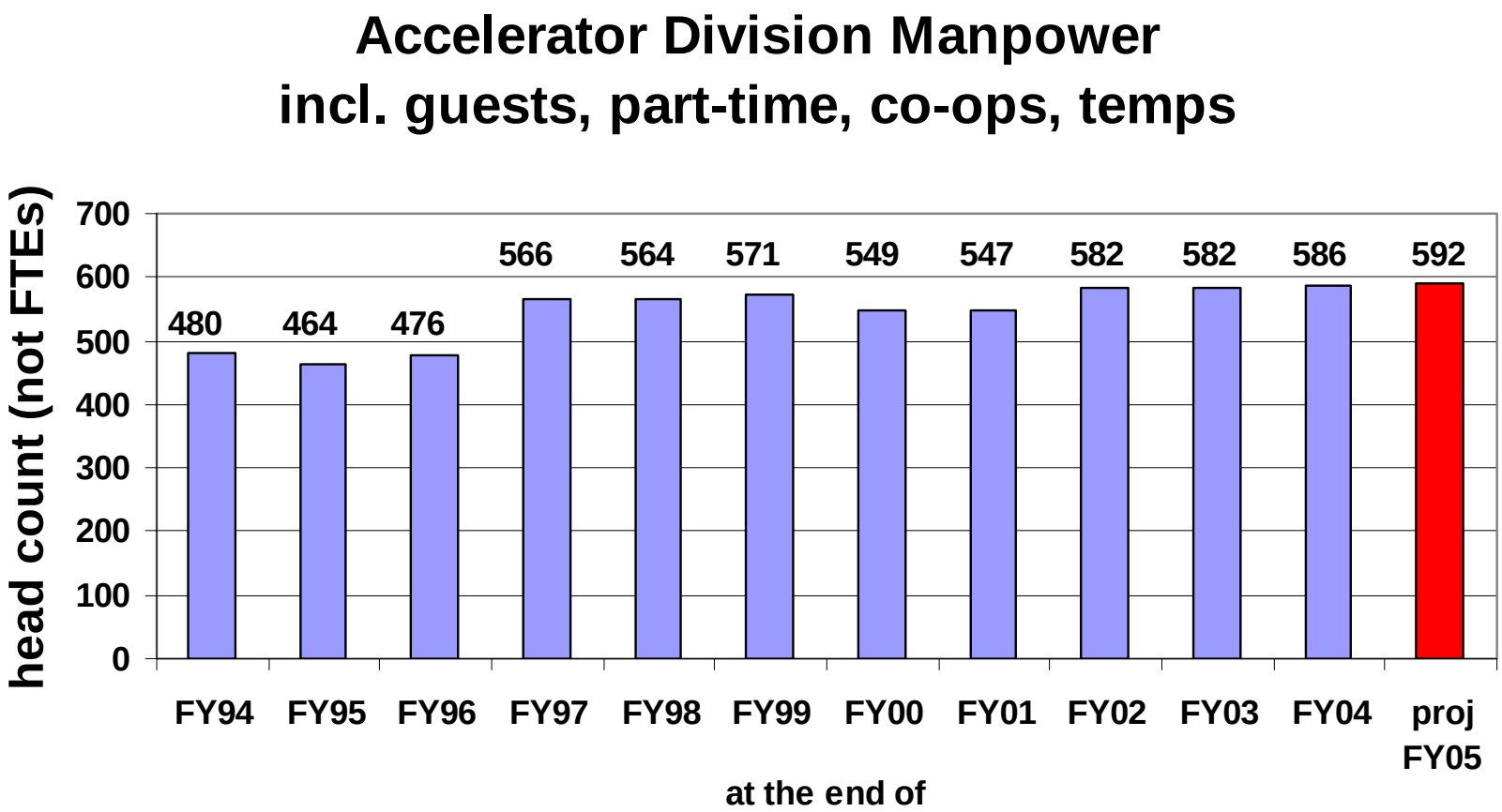
AD Projects: Management Re-organization



Project support team provides help on

- **Maintaining Resource-Loaded Schedule (MS Project) – Domann**
- **Accounting support with Cobra interface to Lab's system - Nestander**
- **General project management support – Sims**
- **Web support - Wehmann**

AD Staffing Levels



AD Staffing by Category

Accelerator Division	headcount 22-Mar-05	subtract non-paid guests	FTEs
ADM	12	12	12
CLR	11	11	11
COOP			
DRF	13	13	13
ENG	96	96	95.6
EPH	31	31	31
MIS	48	48	48
SCI	113	106	105
TCH	180	180	178.8
TSP	81	81	80.2
total AD	585	578	574.6

Unpaid Guest Scientists (7):

Administrative - monthly

Clerical – weekly

Drafters (designers = TSP)

Engineers & Eng. Associates

Engineering Physicists

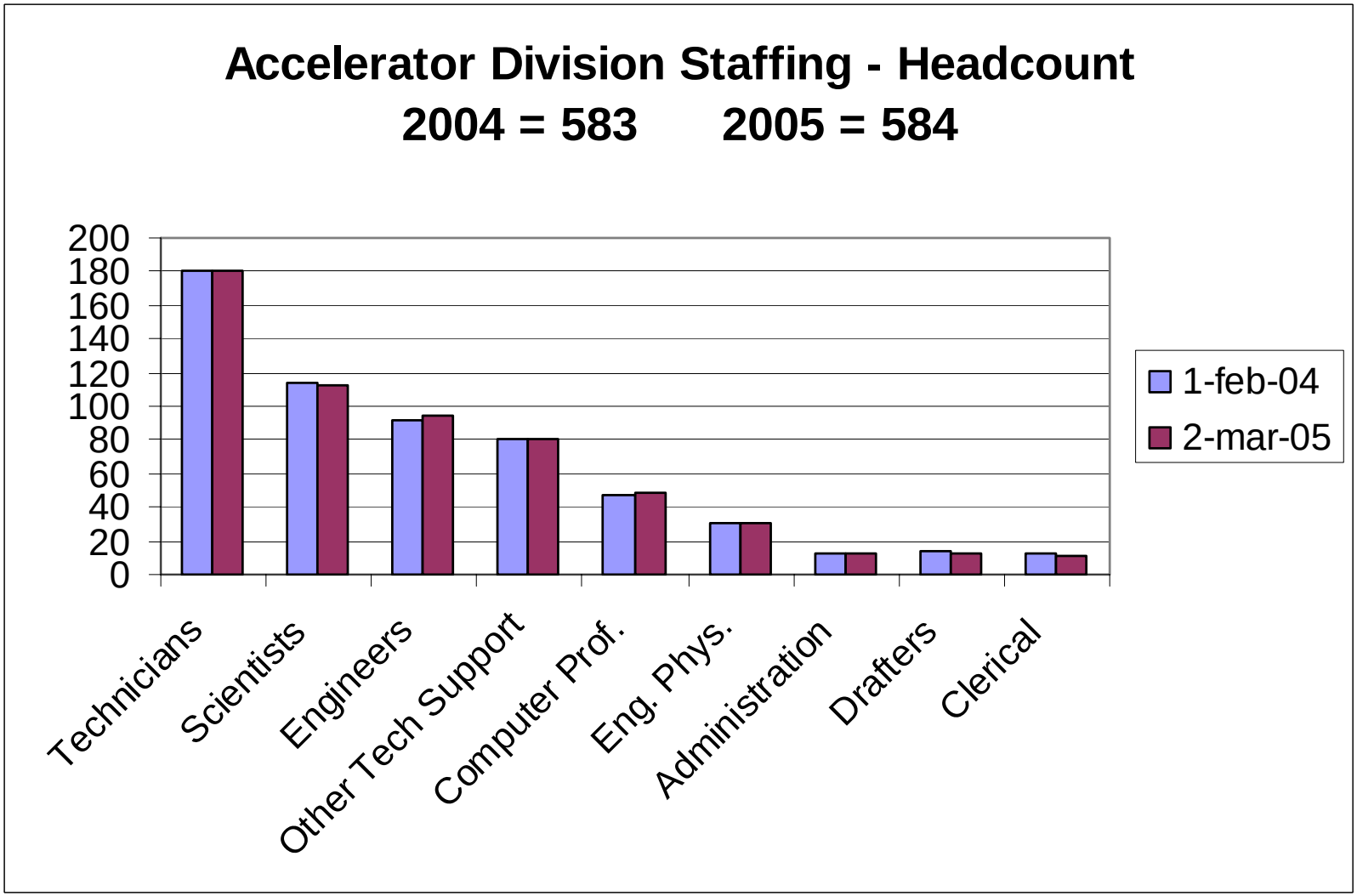
Computer Professionals

Scientists, RA's, Assoc. Sci

Technicians - weekly

Other Technical Support: monthly Technicians, Radiation Physicists, ES&H Specialists

AD Manpower – by classification



AD FY05 FTEs Oct04-Feb05

FTEs in AD integrated over Oct04-Feb05	sum	ADM	CLR	COOP	DRF	ENG	EPH	MIS	SCI	TCH	TSP
Accelerator Maintenance & Operations	307.2	0.3	1.0	2.3	5.9	37.2	17.9	36.2	33.3	127.4	45.6
Proton Improvement Plan	1.1	0.1				0.3			0.6	0.1	
Run II Luminosity Upgrades & Reliability Improvements	74.4	1.8		0.2	4.9	15.7	8.1	4.3	22.6	11.8	5.0
External Beamlines: NuMI, MiniBooNE, SY120	24.8	0.2			0.6	2.7	1.9	3.2	9.5	4.9	1.9
NuMI Beamline Construction	39.8	0.9	1.0			9.0	2.5	0.5	11.3	9.2	5.4
Future Accel R&D (including CKM cavities)	26.4	0.1			1.3	10.4	1.3		6.9	5.5	1.0
Administration, Maintenance, Infrastructure, ES&H	98.9	10.7	8.6	2.6	0.5	10.0	0.2	9.6	6.1	25.4	25.5
BTeV - C0IR operational support & R&D	3.7				0.7	0.2			2.2	0.3	0.4
LHC Accelerator Research Progran - LARP	0.9								0.9		
work for others, NTF, LANL Radiography code, etc	1.7		0.4						1.3		
totals:	579.0	14.0	11.0	5.0	13.9	85.4	31.8	53.9	94.7	184.6	84.7

MIS = Computer Professionals
TCH = Technicians
TSP = Technical Support Staff: Designers, Technical Specialists, Operations Specialists, Radiation Physicists, ES&H Specialists

TD, CD, and PPD support of Accelerator Operations

- A **sample** of recent and continuing activities incl. Accel. Ops, Run II Upgrades, and Proton Plan:
- **Computing Div**: Tevatron and M.I. BPMs, IPMs, analysis support for Shot Data Analysis SDA, Blast DataBase, Tevatron Tune Fitter, Recycler Orbit, Stabilization, Simulations (SCIDAC):
  - Booster space charge
  - Tevatron Beam-Beam interactions

TD, CD, and PPD support of Accelerator Operations (continued)

- **Technical Div**: "support of Run II has priority #1"
  fabricate, modify, and repair components,
  e.g. magnets, E.S. separators, flying wires, etc.,
  for operational improvements,
  Run II Upgrades, and Proton Plan,
  shutdown assistance (~ 20),
  Tevatron magnet shimming, Pbar aperture studies,
  persistent current effects & mitigation,
  C0 IR component design for BTeV, 7835 PAs
  see **TD/AD Job List** (published bi-weekly)
  actively optimized for changing priorities

TD-AD Job List – biweekly
March 23, 2005 – sample of 55 jobs

Key:
Priority: (Determined by AD) 1=Urgent, schedule (summer 05 shutdown or sooner); 2=Urgent, operational need (e.g.,No Spare); 3=Important but less urgent; 4=Proceed with low priority; 5=Defer; 6=Complete; 7=Cancel.

Status: 0=No issue; 1=Stuck due to something (see comments); 2=Dropped or Complete
System: B=Booster; CKM=CKM; EC=Electron Cooling; E907=Experiment 907; FMI=FMI; Gen=AD General Use; L=Linac; MB=MiniBooNE; MC=MuCool; NM=NuMI; Pb=P-bar; PD=Proton Driver R&D; Rcy=Recycler; SY=Switchyard; Tev=Tevatron

Job Number: TD Number for Tracking Jobs

Accelerator Division Tasks as of 23 March 2005

Priority	Status	System	Job No.	Task Name	Scope of Work	TD Contact	AD Contact	Units Req'd	Units Comp	Project	Task	TD Comment	DRAFT TD Schedule
1	0	B	203	OrBump replacements	Design, procure and assemble OrBump replacements.	Makarov	J Lackey	6	0	32 32	EF 1.02.02.01 M+S 1.02.02.01	2/15/2005 Magnetic measurements will continue at MTF. The power strip is to be redesigned to change its basic layout. The girder design is being reviewed.	Complete in May 2005
1	0	B	291	Booster trim package R&D	Fabricate replacements for activated Booster trim packages, perhaps with greater capability. Production to be performed on job #382. (includes job 292)	Harding	J Lackey			32 32 32 32	DT 1.02.03.01 EF 1.02.03.01 MC 1.02.03.01 M+S 1.02.03.01	2/15/05 The mechanical design continues using solid copper and cooling tubes integraded into the coils.	Schedule under development
1	0	B	364	Replacement Booster kicker magnets	Build 10 Booster kicker magnets plus spares with square aperture ceramic beam tubes	Chester Makarov	Lackey	14		30 30 30 30	DT 30.9.1.1.1.8.1 EF 30.9.1.1.1.8.2 MC 30.9.1.1.1.8.3 M+S 30.9.1.1.1.8.9	2/15/05 Design for a rectangular tube has been released for procurement. An order for (30) bare tubes will be placed with the desired end result of (10) complete (brazed) beam tubes plus spares. The ferrite brick design is being updated to reflect tighter tolerancing. Negotiations with the brick vendor suggests this should be no problem, and could hold the previous price.	
1	0	FMI	274	New coils for LEP horizontal correctors	Fabricate replacement coils for the LEP corrector dipoles MCH. Deliver (4) for fall 2004 shutdown. See also job 351.	Makarov	C Gattuso	33	11	30 30 30	EF 30.9.1.1.2.2.2 MC 30.9.1.1.2.2.3 M+S 30.9.1.1.2.2.9	2/15/05 Finished coils are being assembled into old magnet iron.	Balance complete 4/2005
1	0	FMI	295	WQB Larger aperture quads	Design and build wider aperture quads for extraction regions to replace IQB's	Carson	I Kourbanis	9	0	32 32 32	EF 1.03.01.01 MC 1.03.01.01 M+S 1.03.01.01	2/15/05 Winding of the main coil has begun. Curing tooling is expected next week. Stacking tooling was returned to vendor for corrections. We expect to assemble the first magnet without a beam tube fopr testing. Afterward the magnet will be ground apart and reassembled with the beam tube. A brief retest will be performed. Core stacking on subsequent magnets will be delayed pending the first week of testing. (7) magnets are to be completed and tested by 9/21/05.	First mag to MTF 5/05, seventh magnet Sep 2005, spares in FY06
1	0	FMI	351	New coils for LEP verticle correctors	Fabricate replacement coils for the LEP corrector dipoles MCV. Deliver (9) for fall 2004 shutdown. See also job 274.	Makarov	C Gattuso	58	10	30 30 30	EF 30.9.1.1.2.2.2 MC 30.9.1.1.2.2.3 M+S 30.9.1.1.2.2.9	2/15/05 Finished coils are being assembled into old magnet iron.	Balance complete 4/2005
1	0	L	285	Linac Amplifier Tube	Prepare mechanical drawings of existing tubes in FY04	Chester	Czarapata			36 36 36	EF 2.01.01.02.01 MC 2.01.01.02.01 M+S 2.01.01.02.01	1/19/05 Design is in process. An AD visit to the vendor hopes to negotiate terms to rebuild existing units plus manufacture (12) new units at a rate of (6) per year. The fFermilab task force is going to recommend a longer range strategy in a report due by early summer.	

TD, CD, and PPD support of Accelerator Operations (continued)

- **Particle Physics Division**: **alignment** services, **shutdown** assistance (~40 people), **electronics:** pc board layout, fabrication, digital processors, dampers, beam phase monitors, LLRF controls, **detectors & clean room facilities:** BLMs, OTRs, wires & foils for SEMs, scintillators, vacuum pump rebuilds, finite element analysis, beam stops, Pelletron & E-Cooling installation

- **additional alignment support for shutdowns:** ANL, BNL, SLAC, & commercial firms – thanks!

Accelerator Program

ACCELERATOR PROGRAM

16-Mar-05

	FY04	FY05	FY06 PBR	FY07 FLAT	FY08 FLAT	FY09 FLAT
SWF						
ACCELERATOR M&O	34,845.8	34,166.0	37,744.0	37,524.0	37,818.8	38,436.7
ACCELERATOR UPGRADES - R2LU	8,520.2	8,072.7	2,982.0	1,353.4	0.0	0.0
ACCELERATOR UPGRADES - OTHER	4,049.7	2,759.9	3,626.5	3,657.2	3,747.8	3,866.7
PROTON PLAN	0.0	3,473.0	1,929.0	1,899.0	874.7	0.0
EXPERIMENTAL INITIATIVES & EXT BEAMS	2,593.5	2,947.0	3,513.0	3,678.0	3,834.3	4,022.3
NuMI / MINOS	2,676.9	3,297.0	2,502.0	2,530.0	2,637.5	2,766.8
OTHER DIRECT SUPPORT	15,103.6	14,986.8	14,706.0	15,096.0	15,096.0	15,096.0
LHC SUPPORT KA 11 01	141.1	230.0	122.0	127.0	132.4	138.9
SUBTOTAL SWF	67,930.7	69,932.3	67,124.5	65,864.6	64,141.5	64,327.4
M&S						
ACCELERATOR M&O	12,278.3	13,469.0	14,132.0	14,853.0	14,181.2	13,818.6
ACCELERATOR UPGRADES - R2LU	12,444.3	7,547.0	955.0	0.0	0.0	0.0
ACCELERATOR UPGRADES - OTHER	31.3	76.3	406.3	206.3	212.5	218.8
PROTON PLAN	0.0	3,854.0	5,916.8	5,015.8	5,241.7	0.0
EXPERIMENTAL INITIATIVES & EXT BEAMS	632.7	1,174.0	577.0	593.0	610.8	629.1
NuMI / MINOS	860.0	1,149.0	409.0	417.0	429.5	442.4
OTHER DIRECT SUPPORT	3,043.7	2,683.9	2,916.9	2,794.9	2,794.9	2,794.9
SUBTOTAL M&S	29,290.2	29,953.2	25,313.0	23,880.0	23,470.6	17,903.9
SWF + M&S						
ACCELERATOR M&O	47,124.1	47,635.0	51,876.0	52,377.0	52,000.0	52,255.3
ACCELERATOR UPGRADES - R2LU	20,964.4	15,619.7	3,937.0	1,353.4	0.0	0.0
ACCELERATOR UPGRADES - OTHER	4,081.0	2,836.1	4,032.8	3,863.4	3,960.2	4,085.5
PROTON PLAN	0.0	7,327.0	7,845.8	6,914.8	6,116.4	0.0
EXPERIMENTAL INITIATIVES & EXT BEAMS	3,226.1	4,121.0	4,090.0	4,271.0	4,445.1	4,651.4
NuMI / MINOS	3,536.9	4,446.0	2,911.0	2,947.0	3,067.0	3,209.2
OTHER DIRECT SUPPORT	18,147.3	17,670.7	17,622.9	17,890.9	17,890.9	17,890.9
LHC SUPPORT KA 11 01	141.1	230.0	122.0	127.0	132.4	138.9
TOTAL SWF + M&S	97,220.9	99,885.5	92,437.5	89,744.5	87,612.0	82,231.3

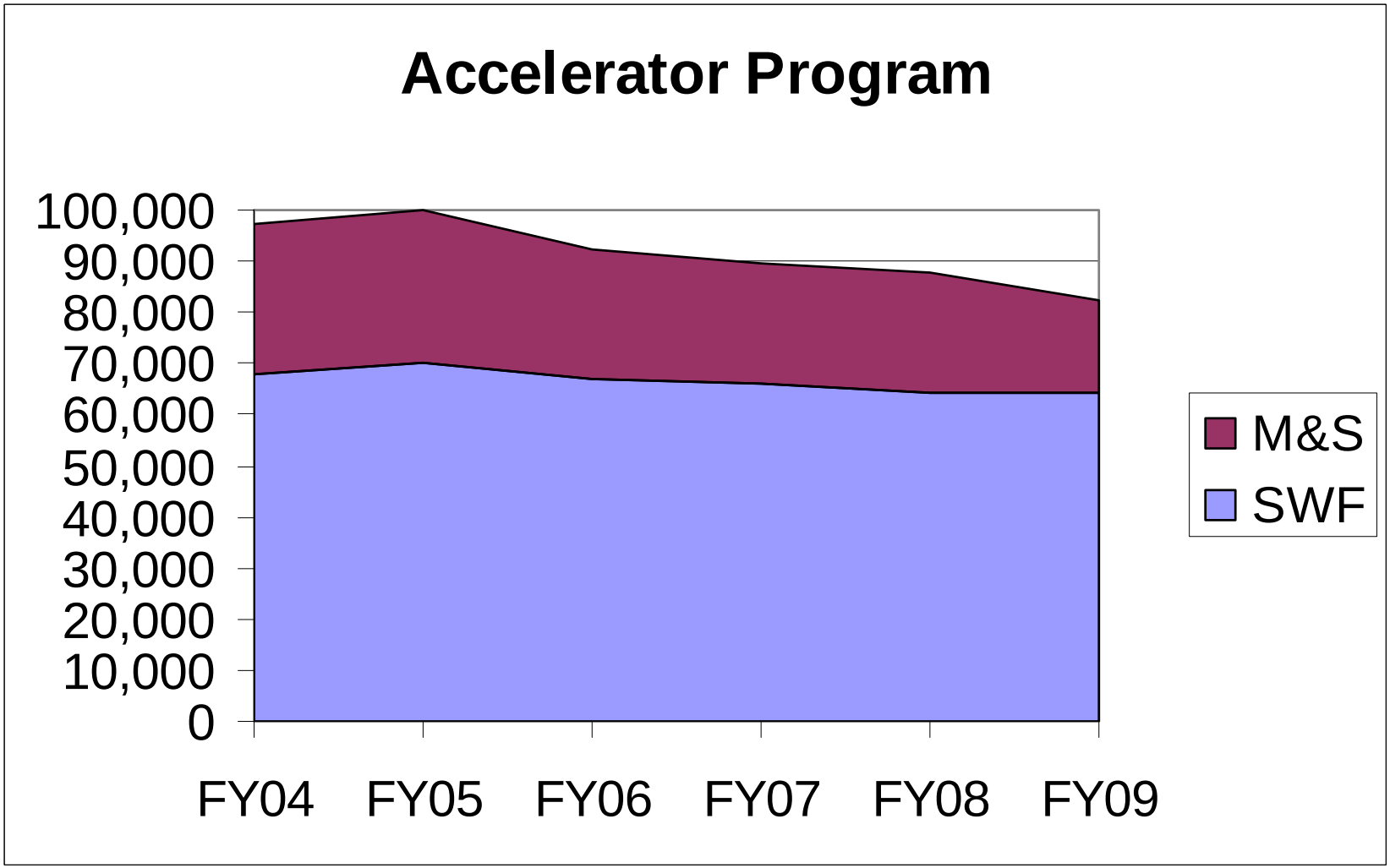
Accelerator Program FTEs

LWWBS – 17march05 – all Divisions

Accelerator Program FTEs	FY04	FY05	FY06 PBR	FY07 FLAT	FY08 FLAT	FY09 FLAT
ACCELERATOR M&O	381.9	359.3	380.9	380.9	351.5	342.9
ACCELERATOR UPGRADES - R2LU	93.4	84.9	30.1	30.1	0	0
ACCELERATOR UPGRADES - OTHER	44.4	29.0	36.6	36.6	34.8	34.5
PROTON PLAN	0	36.5	19.5	19.5	8.1	0
EXP INITIATIVES & EXTERNAL BEAMS	28.4	31.0	35.5	35.5	35.6	35.9
NuMI/MINOS BEAMLINE	29.3	34.7	25.3	25.3	24.5	24.7
OTHER DIRECT SUPPORT	165.5	157.6	148.4	148.4	140.3	134.7
LHC SUPPORT KA 11 01	1.5	2.4	1.2	1.2	1.2	1.2
SUBTOTAL FTEs	744.4	735.5	677.5	677.5	596.2	573.9

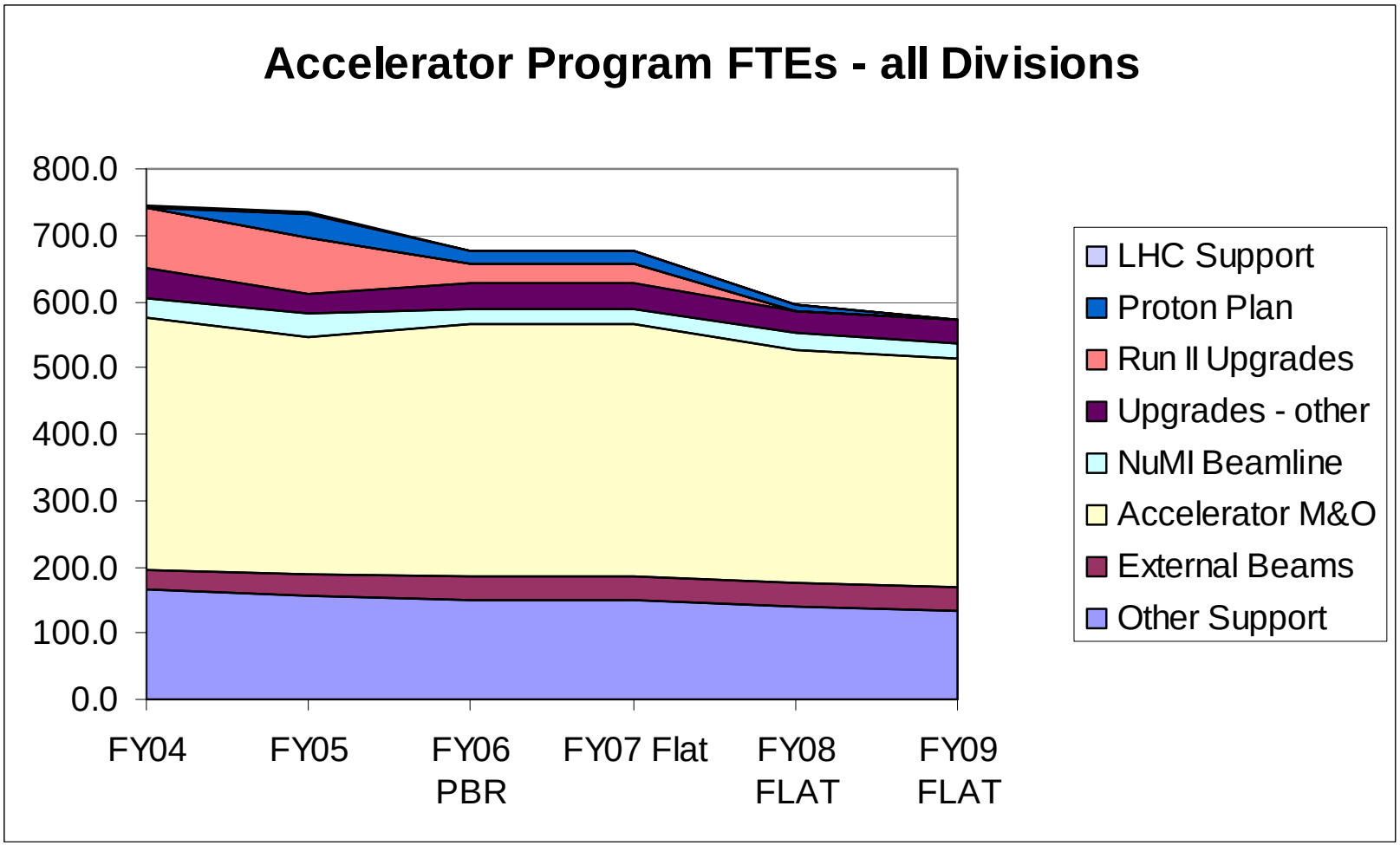
Total Accelerator Program

LWWBS 16march05 - SWF is 77% AD, M&S is 96% AD



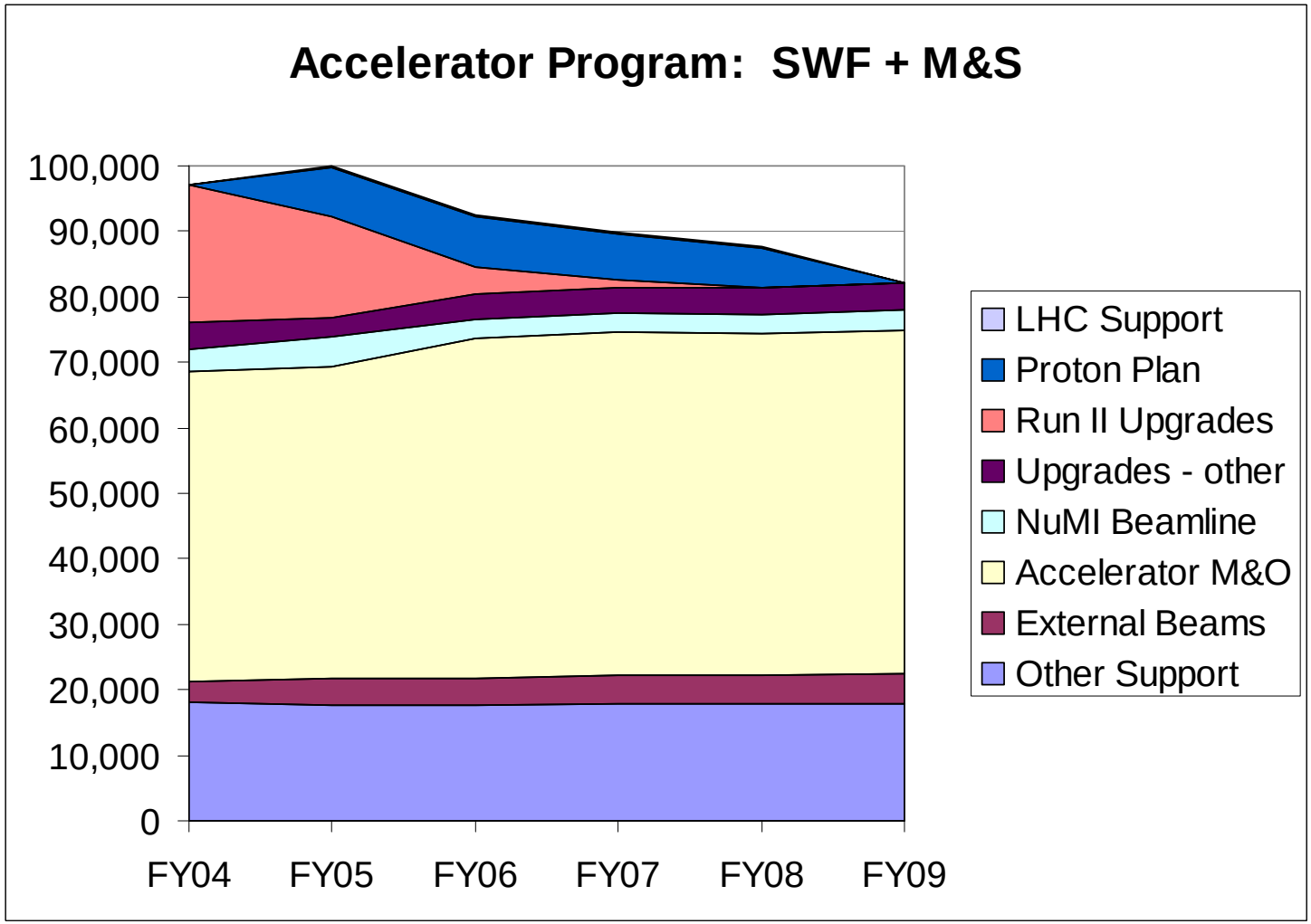
Accelerator Program FTEs

LWWBS – 17march05 – all Divisions



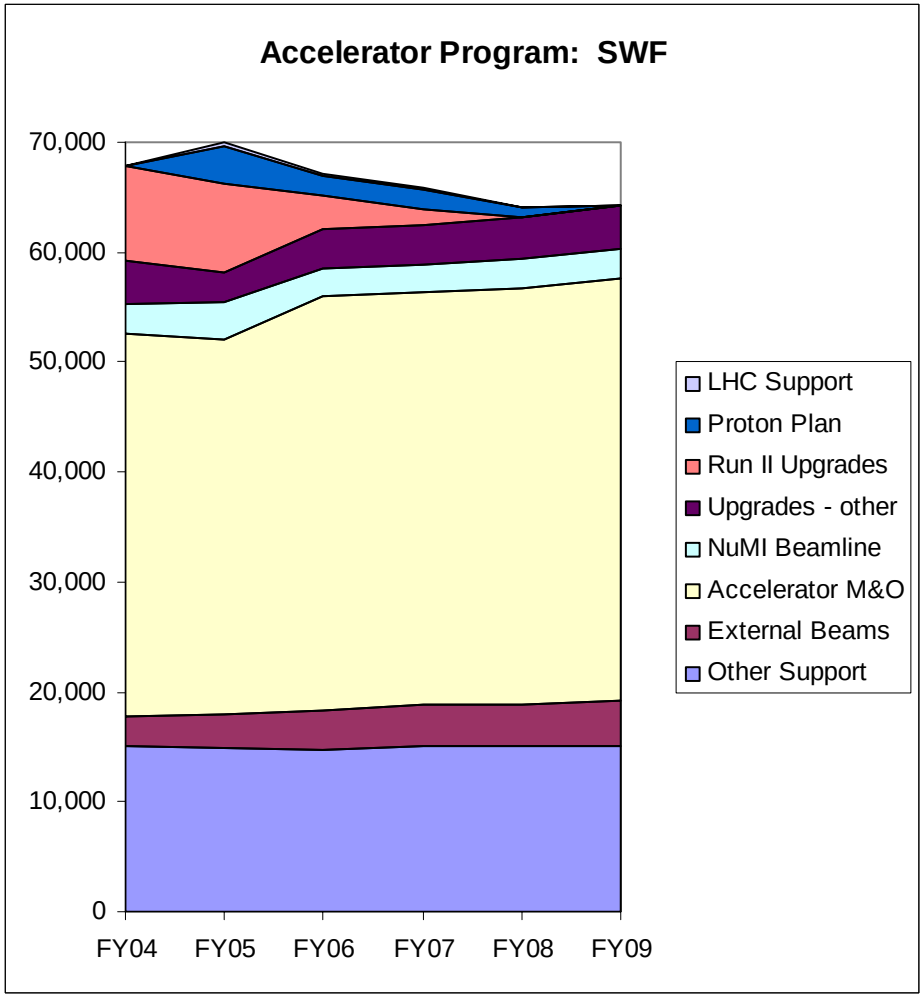
Accelerator Program – SWF + M&S

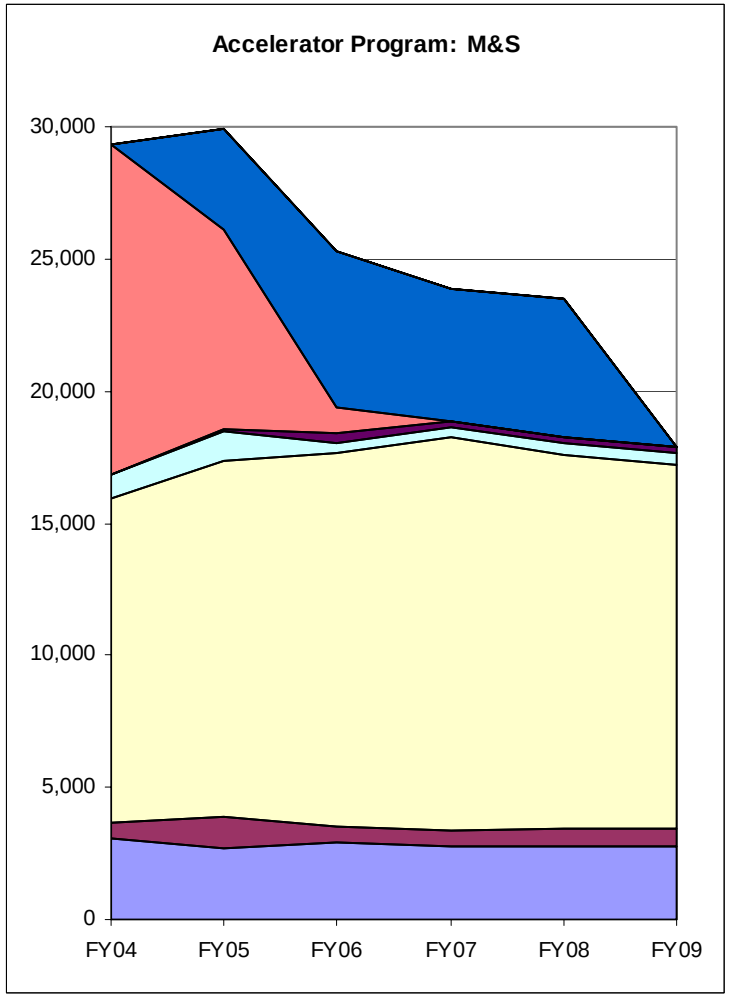
LWWBS - 16march05



Accelerator Program

LWWBS- 16march05





Resource Support for Accelerator Operations

- Budgeted at 100% of needs through FY07
- In FY08-09, support is reduced (10% and 20%) for those components of accelerator complex not needed in FY2010 and beyond
  - Tevatron, Antiproton, and Cryogenics
- Assume additional operational risk – unassessed
- May require re-allocation of skill types
- Non-operations part of program provides a buffer (see Program Review in May, 2005)

AD Manpower Needs for Executing the Program – FY05-09

"The Program" consists of:

- Accelerator M&O
- Accelerator Upgrades – Other
  - (mostly TD & PPD, minor CD, no AD)
- External Beams & NuMI Beam
- Other Direct Support (infrastructure)

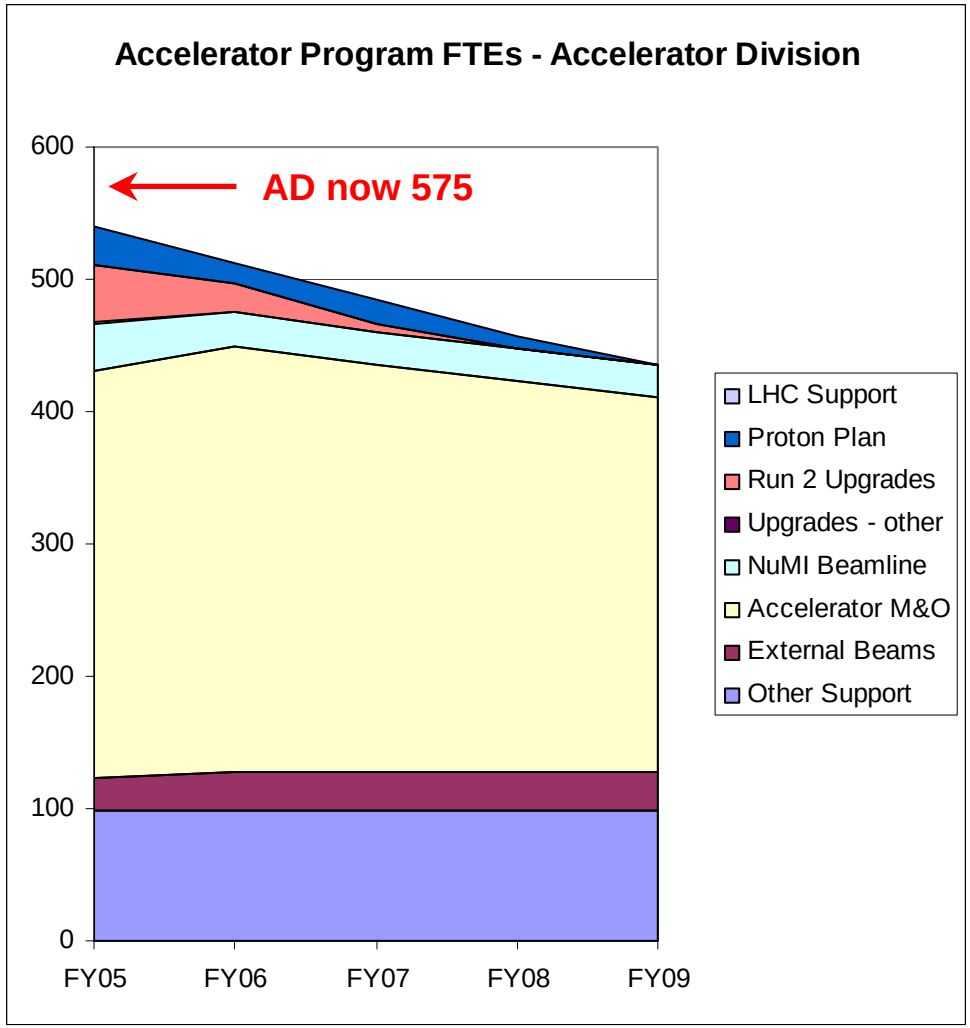
Program needs estimated from

- Operational Experience

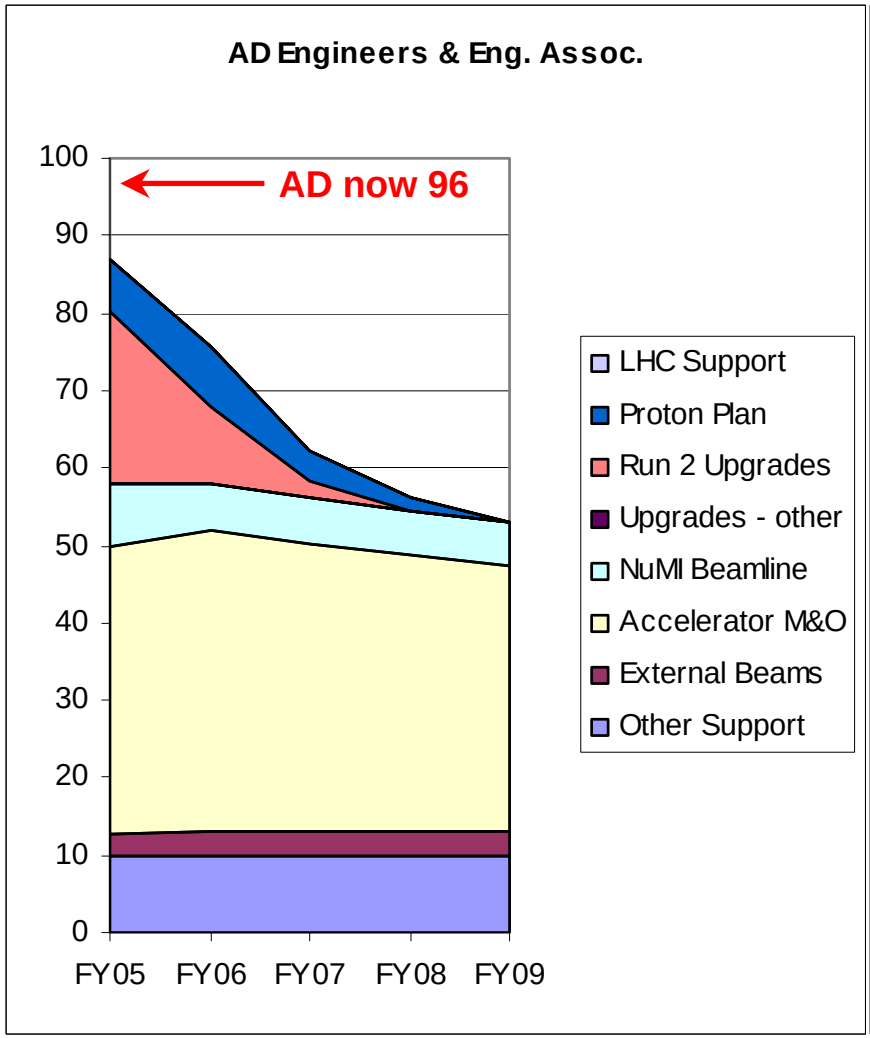
Run 2 Upgrades and Proton Plan

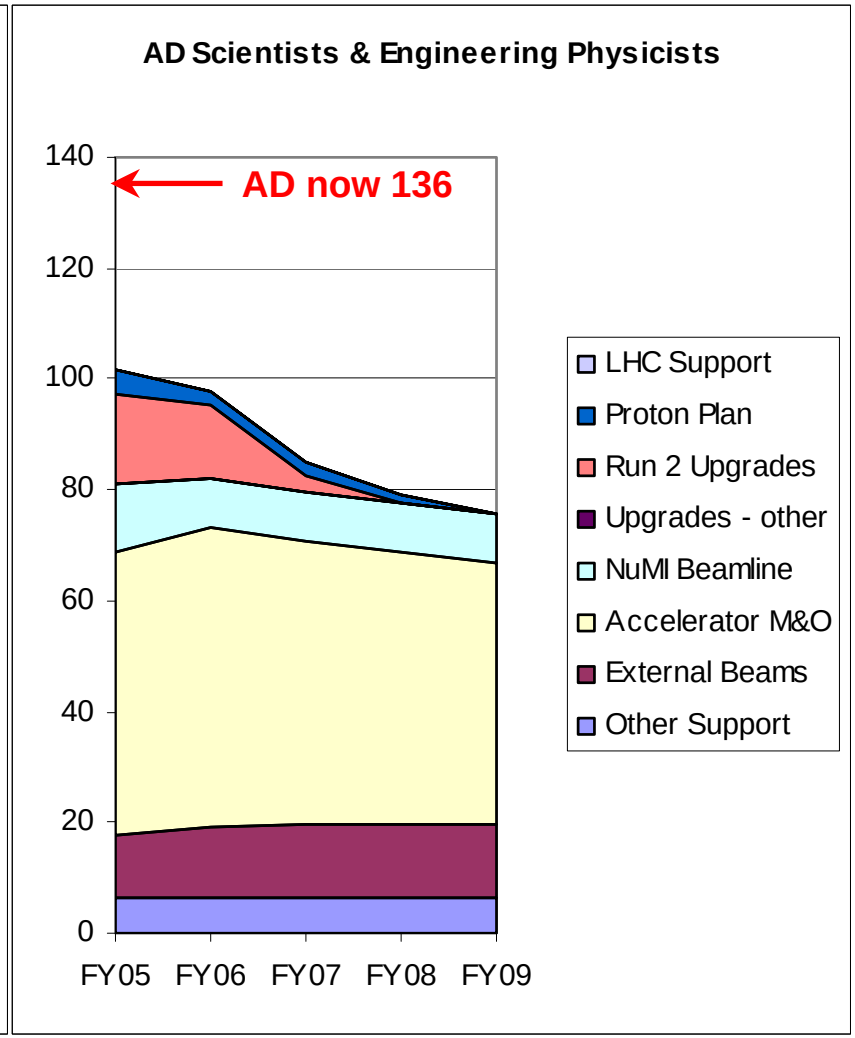
- needs are bottom-up estimates

AD manpower needs for Accelerator Operations FY05-09

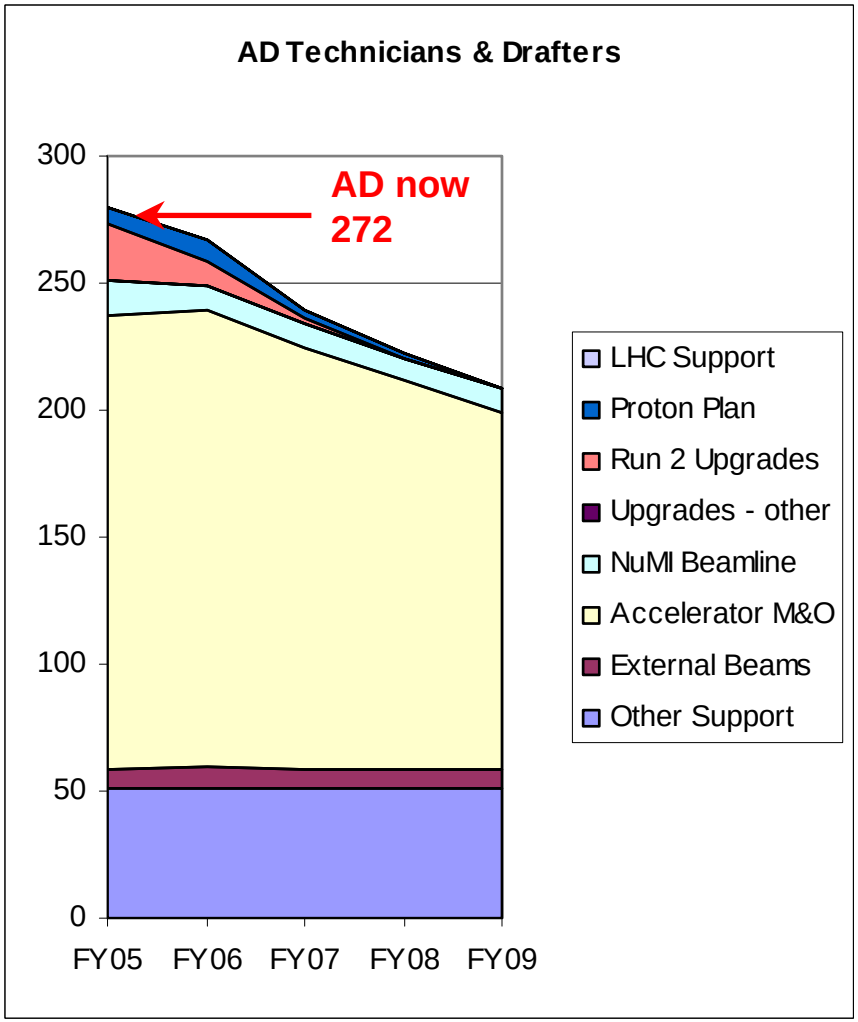


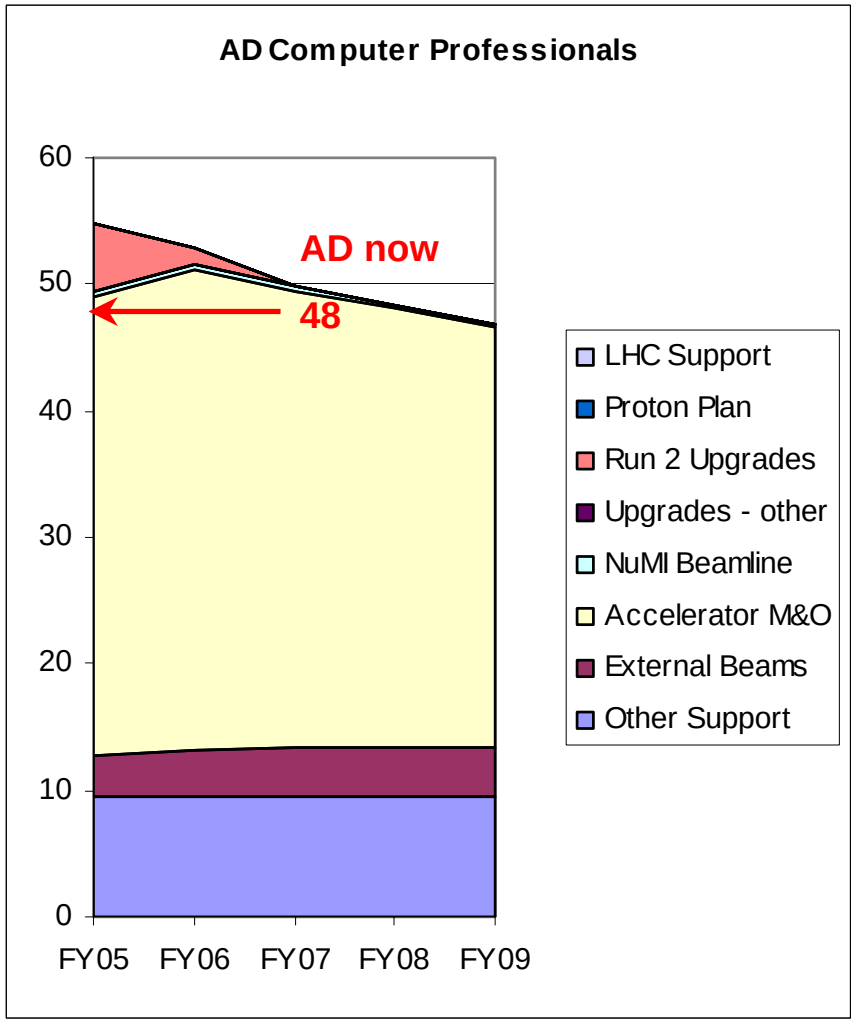
AD manpower needs for Accelerator Operations FY05-09





AD manpower needs for Accelerator Operations FY05-09





Accelerator Program Challenges and Risks

- Performance
  - Luminosity Goals
  - Protons delivered to neutrino program
  - Both of these together
- Equipment Failures
  - 7835 Power Amplifiers
  - Tevatron magnet failures
  - Other Tevatron Damage caused by quenches
  - Electrical Equipment
- Management Risks
  - Loss of crucial manpower as the Tevatron program winds down
  - Inadequate funding for maintenance as more stress is put upon the complex

Risk Mitigation

- Risk planning
  - Luminosity and Proton Projections
  - Fallback strategies
- Continuous assessment
  - Task force assigned as necessary
    - 7835 PA problem
    - BLM added to Run II plan for the Tevatron
- Vulnerability white paper
- Reviews of all major projects with outside reviewers
- Continual management effort to convince the workforce that there is a future at Fermilab

Summary

- The accelerator program continues to provide the highest energy collisions in the world.
- Two unique neutrino beams are operating exploring opening up a new realm of neutrino physics
- Upgrade improvements are being made for both of these important physics programs
- Resources and budgets for the accelerator program are understood for through 2009
- Risks are being minimized within the constraints of declining budgets and outlooks for the program